(11) (CA) No. 949,786

(45) ISSUED June 25, 1974

(52) CLASS 86-5
C.R. CL.

(10) CANADIAN PATENT

(54) POWDER FILLING MACHINE AND METHOD

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(21) APPLICATION No. 131,957
(22) FILED Jan. 7, 1972

(30) PRIORITY DATE

No. OF CLAIMS 10

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CCA-274

Problem and Prior Art

Filling of containers with measured amounts of particulate material has presented practical problems in the past. It has been effected, for example, by weighing charges and transferring to containers, which requires hand labor and permits very limited output per day. A marked improvement with very much greater output was developed in which particulate material flows from a hopper, with suitable stirring or agitation, into successive measuring chambers which are moved past the bottom of the hopper. The particulate material is sucked into each measuring chamber by vacuum, there being provided a foraminous layer so that the particulate material is not drawn out. The measuring chambers are then moved into alignment with containers to be filled, and the charge discharged into the containers by gas pressure. A typical machine or method is described and claimed in the United States patent to Stirn and Taylor, No. 2,540,059. This type of apparatus operates very well with free flowing powders or other particulate material, the particles being of sufficient size so that vacuum compacts the charge in the measuring chamber and the hopper being provided with a doctor blade of metal to smooth off the top surface of the particulate material in each measuring cavity as the latter moves on to discharge its material into a container to be filled.

Some problems are presented in the type of apparatus and method described above when particulate material

the same procedure or organization of elements as in the Stirn and Taylor patent, except of course that the measuringcavities are inverted. However, the results obtainable are quite different. In the first place, a uniform level on the upper surface of the powder in the supply container is readily obtainable by a fixed and non-metallic blade which smooths off the powder to a uniform level. This presents no problem either ofwear or of metal to metal contact with resulting friction which is dangerous with explosive powders. Also, since the charging of the measuring chambers or cavities is entirely by vacuum and does not depend on gravity from an elevated hopper, the non-uniformity which can result from powders having poor flow characteristics is entirely eliminated. Of course the vacuum must be sufficiently strong to pull or suck up the powder, and in the case of powders which are poorly flowable the vacuum may be higher than is the case in the measuring chambers in which the powder is sucked down, as described in the Stirn and Taylor patent.

The discharge by gas pressure when the inverted measuring chambers or cavities have been raised and moved into alignment with the containers to be filled is effected in substantially the same manner as in the U. S. Stirn and Taylor patent above referred to, and in this particular respect the present invention does not differ, but it is an advantage that this very effective method of discharge may be used so that the advantages of the Stirn and Taylor

which is not readily or freely flowable is encountered, and particularly where the material may be explosive, such as propellant powders, powders for igniters, detonators, and the like. The problems presented are caused by two characteristics of the powder. First, if it is not readily or freely flowable, the downward flow in the hoppers may be imperfect; and secondly, where the powder is explosive. In the latter case metal to metal contact or friction must be avoided at all costs because of explosion hazard, and any leakage or spillage presents a very serious hazard. It might be thought that apparatus could be made of non-metallic material, such as plastic, and that this would avoid the hazards as far as explosive powders are concerned. This, however, is not practical as the non-metallic materials wear too fast and spillage becomes an even more serious problem.

Summary of The Invention

The present invention solves the problems presented of poor flowability of powder and particularly of explosion hazards where the powder is explosive by maintaining a uniform free surface of powder in a suitable supply or feed container, preferably capable of continuous or intermittent rotation, and dipping the measuring chambers a predetermined distance into the powder below its surface. Filling the measuring cavity with vacuum and discharge into containers after the measuring chambers are raised and moved into alignment therewith proceeds in general by

Figure 4 is a similar detail after dipping into the powder and filling the chamber by vacuum;

Figure 5 is a similar view after the chamber has been raised;

Figure 6 shows the chamber moving across the string or wire for removing excess powder;

Figure 7 shows the chamber part way to alignment with the container to be filed;

Figure 8 shows the chamber aligned with the container to be filled;

Figure 9 shows the chamber lowered to the container and the powder partly discharged;

Figure 10 shows the measuring chamber raised from the container, and

Figure 11 shows the indexing of another container.

Description of the Preferred Embodiments

Referring to Figs. 1 and 2, the supply hopper is shown at 1, partly broken away in section in Fig. 2. The supply of powder is shown at 2 in Fig. 2 with a feed auger 3 which positively feeds down an amount of powder comparable to that sucked up into the measuring cavities 13 and flows out into an intermittently rotating feed bowl 4, distribution being effected by the cone 11. The hopper 1 is mounted on arm 12 clamped onto a pillar 9 which is mounted in the framework of the machine shown generally at 10. Intermittent movement of the bowl 4 is effected by the air cylinder 8 and ratchet wheel 7. This is best

process in this step are fully retained. Another advantage of the present invention is that since the measuring chambers or cavities are inverted, it is not necessary to have a doctor blade or similar element which presents a rubbing problem. On the contrary, a simple non-metallic string or wire across which the bottom openings of the measuring cavities are moved after raising from the powder level suffices to assure that no excess of powder is present at the open ends of the measuring chambers or cavities. These non-metallic strings or wires of course do not present any problem of metal to metal contact or of spillage due to wear, and so the invention eliminates both of these undesirable elements and is, therefore, well suited for the rapid filling of containers with explosive powders, such as for example shells, blasting caps, and the like. The invention is, of course, not limited to the use of the apparatus with explosive powders, and it can be used with other powders, free flowing or not free flowing. However, as the invention is of particular utility in the filling of explosive powders which do not flow freely, this constitutes a preferred field of use of the method.

Brief Description of the Drawings

Figure 1 is a plan view of the apparatus;

Figure 2 is an elevation, partly broken away and in section, of the apparatus;

Figure 3 is a detail of one measuring chamber moved into position over the powder supply just prior to dipping in;

Fig. 2 shows a second air cylinder 27, double acting, which moves periodically to raise and lower the plate 15. The amount of vertical plate travel is shown by the double arrow in Fig. 2.

Figs. 3 to 11 show successive positions of operation in the machine and will be described. One further element, a non-metallic string or wire 29 is present, which does not show on some of the other figures. As the bowl 4 turns, the non-metallic blade 5 smooths out the surface of the powder, which is kept from clumping or aggregating by the rakes 6. This mechanism is shown in Fig. 2 and Fig. 3 shows a section through the bowl just after the level of the powder has been formed by the blade 5. One of the measuring chambers 13 is shown as having beenmoved over the powder, the direction being indicated by the horizontal arrow.

The cylinder 27 now pulls backcausing the plate 15 to lower and the mouth 14 of the measuring chamber 13 to dip into the powder. This is shown in Fig. 4, the downward motion of the plate 15 being indicated by a vertical arrow, and the vacuum flow in the broken away tube 16 being indicated by a second vertical arrow. The vacuum sucks the chamber full and leaves a slight excess of powder on the end of the mouth 14 as appears in Fig. 4. Now the cylinder 27 raises the plate 15 once again to the position shown in Fig. 5, and Fig. 6 shows the chamber 13 moving around to the right and across the non-metallic string or wire 29, which removes excess powder, as is shown in Fig. 6.

seen in Fig. 2, which also shows the leveling of the powder by the non-metallic blade 5 and rake 6 which prevent clumping or aggregating of the powder.

Measuring cavities 13 with mouths 14 are arranged in pairs in a movable disc 15. The chambers are connected by tubes 16 to connections 17 to a vacuum manifold 18 except for the position over containers to be filled where they connect to a pressure manifold 19, held down by spring 28. These manifold connections are shown only diagrammatically as their particular structural details form no part of the present invention. The plate 15 is turned by a shaft 20 which is supported by an arm 21 and the plate 15 is turned by the gear 26. The above motions are best seen in Fig. 1.

The drawings show a modification of the machine for filling of cartridges which are not self-supporting and are, therefore, mounted in pairs in boats 22, the cartridges being shown at 23. The boats are moved along a track 24 by means of a star wheel 25. This is best seen on Fig. 1. The star wheel is driven intermittently by an eight station rotary air table 30. As this is a standard item, internal construction is not shown. The drive is synchronized with the movement of the plate 15. The measuring chambers are thus moved by means of gear 31 which meshes with gear 26, so that pairs of cartridges are presented to the chambers for discharge, which is shown with respect to one of the boats 22, numbered 22A on Fig. 1.

tained when the machine is used for filling non-explosive powders even though in such a case metal to metal contact need not be eliminated. When used with very free flowing powder, it is possible to eliminate the anti-aggregating rakes 6, but as they are cheap and simple, it is usually preferable to include them even though the machine is to be used with free-flowing powders.

Fig. 7 shows the measuring chamber 13 moving still further and brought to register with a container 23 in Fig. 8. The air cylinder 27 now lowers the plate 15 to bring the mouth 14 of the chamber 13 into alignment with the opening of the container 23 and connection is made through the pipe 16 to the air pressure manifold 19. This causes the air pressure to discharge the powder contained in the measuring cavity into the cartridge 23. Fig. 9 shows the situation just before the last of the powder has been blown into the container, the vertical arrow into tube 16 showing the direction of flow of air.

The plate 15 is then raised again by the cylinder 27 to the position shown in Fig. 10, and the chamber 13 moves along to the right as shown in Fig. 11, and now the star wheel 25 starts to move a boat 23 into position to register with the next pair of measuring chambers. When the plate 15 moves, it brings more chambers into the position shown in Fig. 3, and the sequence of operations just described is repeated.

It will be seen that at no point in the operation is there metal to metal friction, and there is no possibility of wear which would cause spillage. The leveling string or wire 29 has sufficient give so that it always levels the bottom of the mouth 14, removing all excess powder.

The description above has been in conjunction with the filling of explosive powders, the most important single field for the present invention. All of the advantages of uniform filling, lack of spillage, and the like are ob-

2. A machine according to Claim 1 comprising a plurality of measuring chambers mounted in a rotatable plate and the means for moving a chamber periodically over the top of the level surface of powder and lowering it into the powder comprises means for intermittently rotating the plate to position at least one chamber over the level upper surface of the powder and to align it at a later time with a container to be filled and means for raising and lowering said plate whereby chambers are dipped into the powder, raised, moved to alignment with a container to be filled and lowered to position adjacent the mouth thereof.

3. A machine according to Claim 2 in which the means for producing a level upper surface of powder comprises a rotatable bowl and a stationary leveling blade.

4. A machine according to Claim 3 in which the means for removing excess powder is a stationary element positioned above the powder containing bowl at a height such that it contacts the mouth of the measuring chamber when the latter is raised from the powder surface during its movement to align with a container to be filled.

5. A machine according to claim 4 in which the element is a non-metallic string or wire whereby metal to metal contact is avoided during the operation of the machine.

6. A machine according to Claim 5 for filling non-self-sustaining containers in which the containers are supported in movable elements and these elements are moved to effect alignment of the containers to be filled with the measuring chambers filling them.

What Is Claimed Is:

1. A machine for uniformly filling containers with powdered material, comprising in combination

a vessel and means for producing a uniform level top surface of powder therein,

at least one inverted measuring chamber, the cross section of the chamber being very much smaller than the cross section of the vessel, means for connecting said chamber at predetermined intervals to vacuum and gas under pressure, said chamber including as one of its walls a gas pervious but powder impervious material said wall being situated between the vacuum and the measuring chamber proper, whereby powder can be sucked up into the chamber by vacuum without being sucked through it,

means for moving said chamber periodically over the level top surface of powder and lowering it into the powder while connected to the source of vacuum whereby powder is sucked up filling the chamber,

a plurality of containers to be filled and means for indexing them to successive predetermined positions,

means for removal of excess powder sucked up beyond the mouth of the measuring chamber,

means for moving the chamber into alignment with the container to be filled and closely adjacent to the mouth thereof, and

means for applying gas pressure to the chamber when aligned with the container mouth to discharge the powder therein.

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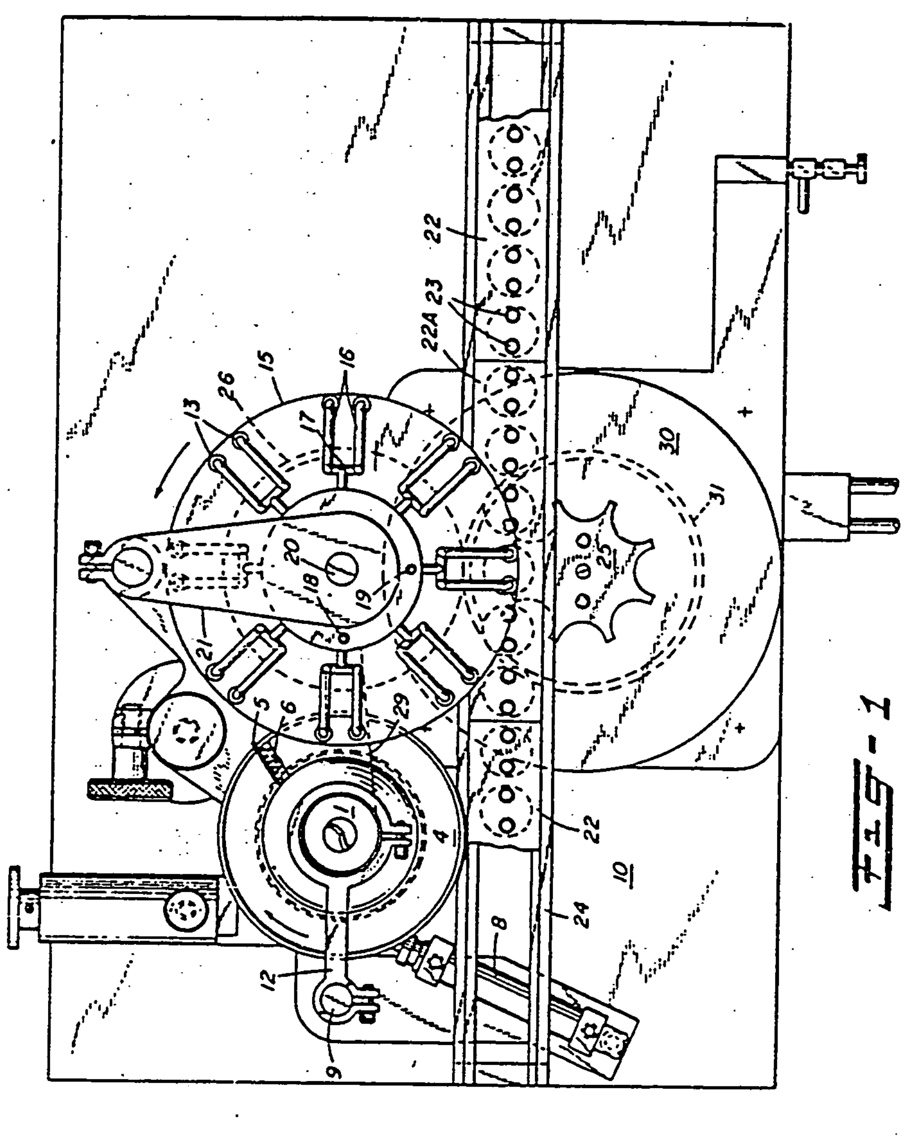

FIG-1

7. A machine according to Claim 6 in which the means for indexing the containers to successive predetermined positions comprise a track along which the elements move and the movement of the containers is by periodic intermittent motion of a star wheel positioned to contact the elements.

8. A machine according to Claim 6 for the filling of explosive material in which the moving means for moving the measuring chambers and containers are pneumatically driven.

9. A method of filling containers with powder comprising the following steps:

establishing a level upper surface of powder,

dipping a measuring chamber through said level upper surface and sucking up a predetermined volume of powder by vacuum into said measuring chamber,

removing excess powder from the bottom opening of said chamber,

moving the chamber into register with a container to be filled, and

discharging the powder therein by gas pressure.

10. A method according to Claim 9 in which the powder is an explosive powder.

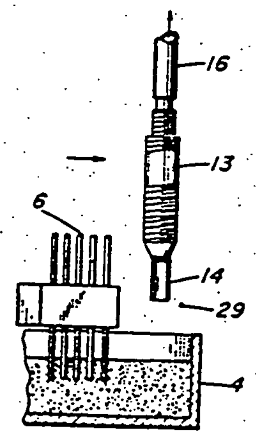

Fig - 3

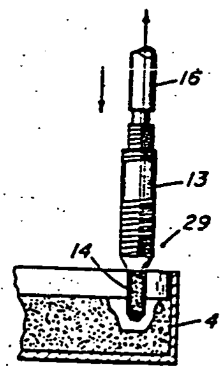

Fig - 4

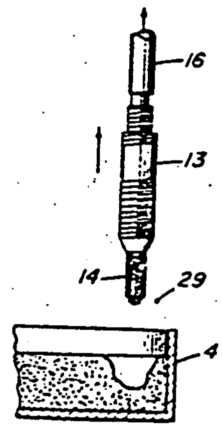

Fig - 5

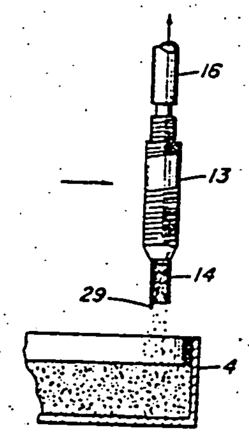

Fig - 6

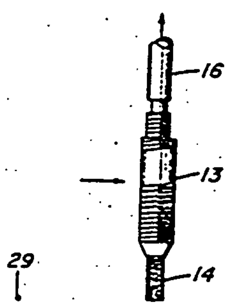

Fig - 7

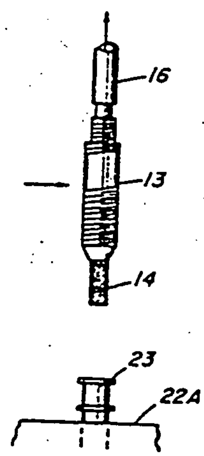

Fig - 8

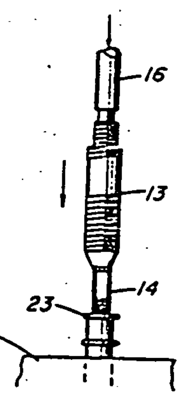

Fig - 9

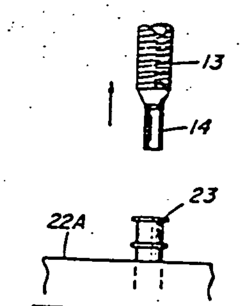

Fig - 10

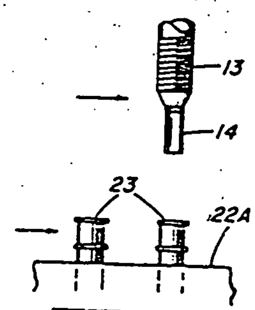

Fig - 11

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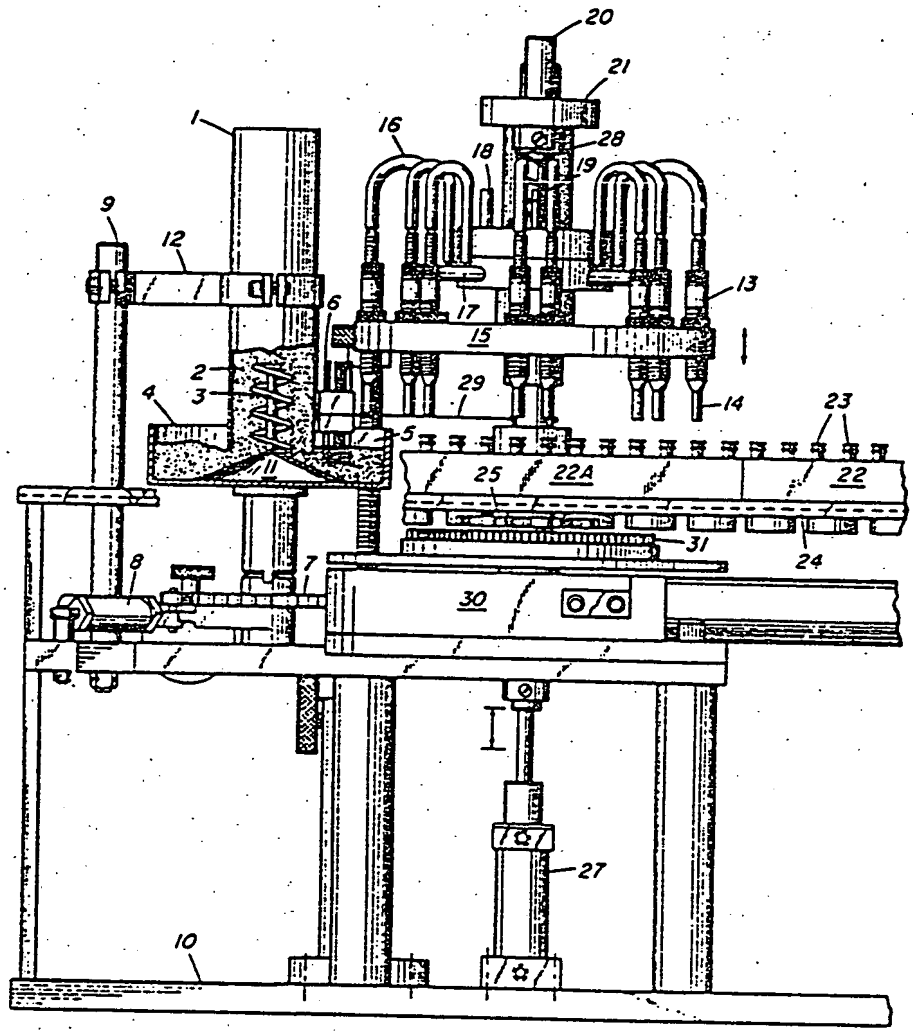

FIG-2